UNICELLULAR GLANDS IN THE LARVÆ OF ERISTALIS TENAX

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INTRODUCTION

There occur in certain insects some very remarkable unicellular glands which have aroused the interest of various investigators. These glands were described by Leydig (1859) in several insects. Batelli (1879) who first observed them in *Eristalis tenax* made some accurate observations on their structure in fairly mature larvæ, but his observations were not complete. He maintains that they "form an apparatus adapted to the state and functions of the respiratory tube." Viallanes (1885) maintains that they are a new type of elastic tissue forming the mechanism by which the tail is shortened. Gazagnaire (1886) ridicules Viallanes' views and contends that the function of the glands is to furnish an oiling fluid for the lubrification of the breathing tube. Wahl (1889) accurately described the glands in rather old larvæ of *Eristalis* and maintains that they furnish a secretion which oils the tip of the tail, thus preventing water from adhering to the end of the respiratory tube and from entering it. His conclusion that the secretion is of an oily nature is based entirely upon its optical properties.

According to Wahl, similar glands are found in rather mature larvæ in connection with other respiratory tubes in the anterior end of the larvæ. He concludes that these anterior glands form an oily secretion which aids the insects in remaining at the surface of the liquid in which they live.

Krüger (1926) described similar gland cells in *Syritta,* a fly closely related to *Eristalis.* According to Krüger, similar cells have been found in many Muscidæ, for example in *Polietes lardaria* (Fabr.) by G. W. Müller, which secrete carbon dioxide, thus playing a rôle in respiration.

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Giacomini (1900), who observed these gland cells in larvæ of various ages, accepts Wahl's view as to their function but thinks that they probably have another more important function, perhaps that of protecting with a bactericidal action the opening of the respiratory tubes from the invasion of microorganisms.

Because of the diversity of views concerning the structure and function of these glands, and since no previous investigator has described them fully in very young larvæ of *Eristalis tenax,* a study was made of them.

MATERIAL AND METHODS

The larvæ were obtained as follows. Adult female flies were collected in July and August in Woods Hole. At this season they are very abundant, feeding upon various flowers. The flies were brought into the laboratory and kept in small wire cages. They were fed on cane sugar and water was constantly available to them. During this season many female flies contain numerous fertilized eggs. When kept under the above conditions they frequently deposit a mass of eggs within a few hours after they are brought in. The eggs were removed from the floor of the cage and placed on the surface of tap water in a finger bowl. After about twenty-four hours the eggs hatch and the larvæ collect on the side of the dish nearest the light. They are highly positive to light for a few hours and then become highly negative.

Those larvæ which were to be kept alive were transferred within a few hours to a jar containing human feces. In this they lived well up to the time of pupation. As is well known, the larvæ of *Eristalis* are commonly called rat-tailed larvæ. Their posterior end is much extended in the form of a long tail-like structure. Opening at the end of this structure are two large tracheæ. The larvæ keep the ends of their tails above the surface of the liquid as they move around in the material upon which the feed.

Those larvæ which were used in the present work were removed from the water about twenty-four hours after hatching. They were placed upon a slide, covered with a few drops of fixing solution, and pressed flat with another slide. After they had been

killed in the flattened condition they were removed to a bottle of the fixing solution for a short time and then preserved in alcohol. Three fixing solutions were used: Bouin's, Flemming's, and Carnoy's. The last proved useless because of the distortion it produced.

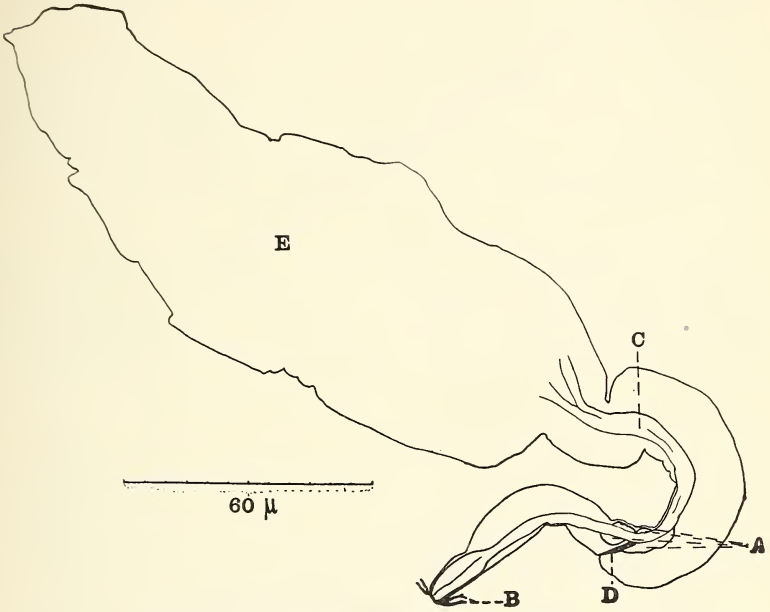

FIGURE 1. *Camera lucida* outline of a larva of *Eristalis tenax* about 24 hours old. E, body; C, tracheæ in tail; A, unicellular gland cells; D, muscle fibers; B, filaments at end of tail.

Larvæ of the age described above are highly transparent in the living condition and, when stained and mounted *in toto*, make beautiful preparations.

STRUCTURE OF THE GLANDS

Figure 1 is a *camera lucida* outline of one of these larvæ. As is shown in this figure, there are located in the tail a number of unicellular glands closely attached to the respiratory tube. The gland cells are 6 in number in larvæ of this age. As is shown in

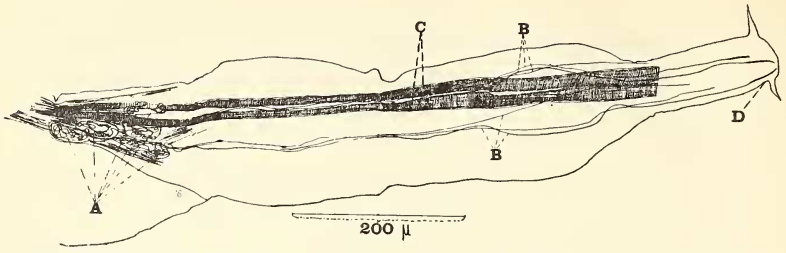

FIGURE 2. *Camera lucida* drawing of part of the tail of a larva of *Eristalis tenax* about 24 hours old. A, unicellular glands, in each of which is a much convoluted canal containing the secretion stained black with Flemming's fixative; B, secretion in cavities of protoplasmic threads of unicellular glands; C, tracheæ in tail of larva; D, posterior end of tail.

figures 2 and 3, from each gland cell there extends a very thin, long, thread-like protoplasmic process to the end of the tail. The preparation from which figure 2 was drawn did not show the end of the tail clearly, but this was shown beautifully in the

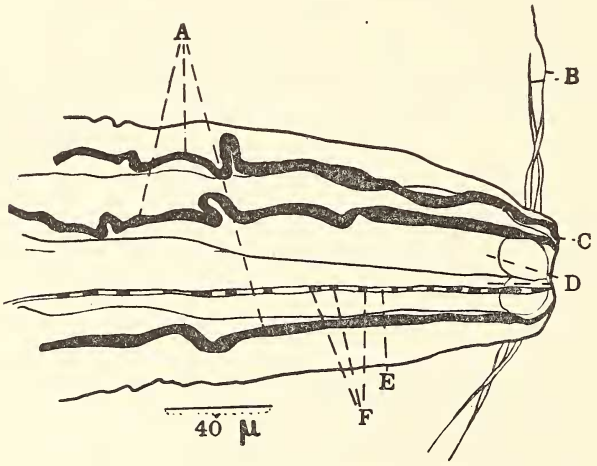

FIGURE 3. *Camera lucida* drawing of posterior end of larva of *Eristalis tenax* about 24 hours old. D, tracheæ in tail; B, filaments at end of tail; A, secretion in canals of protoplasmic threads of unicellular glands stained black with Flemming's fixative; F, droplets of secretion in canal in protoplasmic thread of gland cell; E, canal in protoplasmic thread of unicellular gland; C, location of external opening of hollow protoplasmic thread of gland cell.

preparation from which figure 3 was drawn. The protoplasmic process contains a minute cavity which extends from end to end and continues into the cell body where it forms a convoluted tubule in the cytoplasm of the cell. (Fig. 5, C.) This canal apparently does not come in contact with the large nucleus shown in figure 6.

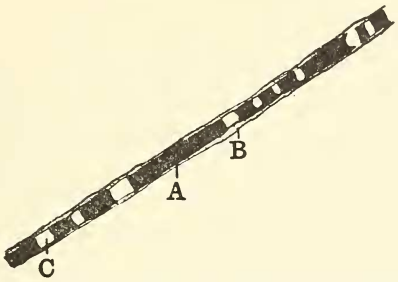

FIGURE 4. *Camera lucida* drawing of portion of protoplasmic thread of unicellular gland fixed in Flemming's fixative. ×1900. C, canal in thread; B, wall of hollow thread; A, secretion of gland cells broken up into droplets in the canal and stained black with Flemming's fixative.

As stated above, according to Wahl, similar cells occur in the anterior ends of fairly mature larvæ in connection with two respiratory tubes located in this region. At the age of about twenty-four hours neither of these two respiratory tubes nor their associated gland cells have yet developed in the anterior end of the larvæ.

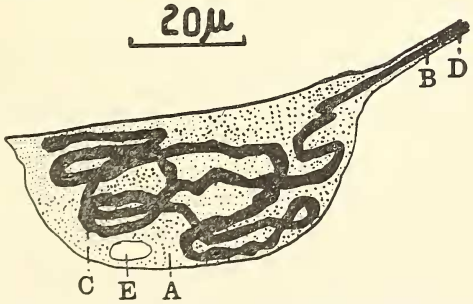

FIGURE 5. *Camera lucida* drawing of unicellular gland from the tail of a larva of *Eristalis tenax* fixed in Flemming's fixative. A, cytoplasm of cell; B, wall of hollow protoplasmic thread; C, secretion of gland cell stained black with Flemming's fixative in convoluted canal in gland cell; D, secretion in canal in protoplasmic thread of gland cell; E, vacuole.

NATURE OF THE SECRETION OF THE GLANDS

The secretion of these unicellular glands is an oily liquid which flows out at the end of the tail. That it is a liquid is conclusively proved by the fact that frequently the secretion is seen broken up in drops in the cavity of the protoplasmic processes of the cells (Fig. 3, F and Fig. 4, A).

That it consists certainly in part of a fatty substance is shown by the fact that in larvæ fixed in Flemming's fixative the secretion is stained a dense black. Figures 1–5 were drawn from larvæ fixed in Flemming's fixative and mounted without further staining. In these larvæ the secretion in the protoplasmic processes of the gland cells frequently resembles a minute black thread. It is easy to understand how Viallanes was misled in maintaining that it is a solid fiber. In larvæ fixed in Carnoy's or in Bouin's fixative it is very difficult to distinguish the unstained protoplasmic processes. However, in one preparation fixed in Bouin's fixative and stained in Delafield's hæmatoxylin clear outlines of the convoluted canal in the cytoplasm of the cell were beautifully shown.

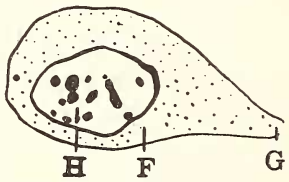

FIGURE 6. *Camera lucida* drawing of a gland cell from the tail of larva of *Eristalis tenax* fixed in Bouin's fixative and stained in Haidenhain's iron alum hæmatoxylin. ×1900. H, nucleus; F, cytoplasm; G, anterior end of protoplasmic process.

THE FUNCTION OF THE SECRETION

The function of the glands is not to form a lubricating material for the respiratory tube, as Gazagnaire maintains, because the external opening of the glands is not in the proper position for this. It is not to furnish a mechanism for shortening the respiratory tube, as Viallanes maintains, because it is not of the

structure necessary. No evidence was found in favor of the views that the secretion plays a rôle in respiration or that it exerts a bactericidal action. The function of the glands is probably to furnish an oily secretion which prevents water from entering the end of the respiratory tube and aids in maintaining the end of the tail at the surface of the liquid material in which the larvæ live, as Wahl suggests.

Summary

1. There occur in the tails of larvæ of *Eristalis tenax* about twenty-four hours old 6 unicellular glands.

2. These glands have very long thin tubular protoplasmic processes which extend to the end of the tail.

3. The cavity of the process continues into the cytoplasm of the cell in the form of a very much convoluted tubule.

4. The secretion of these glands is in part at least of a fatty nature.

5. The function of this secretion is probably to oil the end of the respiratory tube, thus preventing the entrance of water and aiding in supporting the end of the tail at the surface of the liquid in which the larvæ live.

Literature Cited

BATELLI, A. 1879. Contribuzione all' anatomia ed alla fisiologia della larva dell' Eristalis tenax. Bull. soc. entomol. Ital., Vol. 11, pp. 77–120.

GAZAGNAIRE, J. 1886. Des glandes chez les Insectes.—Sur un prétendu "nouveau type de tissu élastique." Cpt. rend. hebdom. des séances de l'acad. des sciences. T. 102, pp. 1501–1503.

GIACOMINI, ERCOLE. 1900. Contributo alle conoscenze sull' organizzazione interna e sullo sviluppo della << Eristalis tenax, L >> — Osservazione e annotazioni. Annali della Facoltà di Medicina e Memorie della Accademia Medico-chirurgica di Perugia. Vol. 12, pp. 131–219.

KRÜGER, FRIEDRICH. 1926. Biologie und Morphologie einiger Syrphidenlarven. Zeitschr. Wissens. Biol. Abt. A. Zeitschr. Morphol. u. Ökel. Tiere. Bd. 6, S. 83–149.

LEYDIG, FRANZ. 1859. Zur Anatomie der Insecten. Arch. f. Anat. u. Physiol. v. Reichert und du Bois Reymond. Jahrg. 1859. pp. 33–89, 149–183.

VIALLANES, M. H. 1885. Sur un nouveau type de tissu élastique, observé chez la larve de l'Eristalis tenax. Ann. des sc. nat. S. 6, T. XI, II. Art., 12 pag.

WAHL, BR. 1899. Über das Tracheensystem und die Imaginalscheiben der Larve von Eristalis tenax. Arb. a. d. zool. Inst. Wien. Bd. 12. S. 21–54.